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(54) SLIP CONTROL SHEETING AND ARTICLES COVERED WITH SAME

RUTSCHFESTER BELAG UND DAMIT BEDECKTE GEGENSTAENDE

REVETEMENT ANTIDERAPANT ET ARTICLES POURVUS DU MEME REVETEMENT

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(56) References cited:
WO-A-85/04592
DE-A- 3 203 023
FR-A- 2 669 543
US-A- 4 488 918
DE-A- 2 807 658
FR-A- 2 125 305
GB-A- 2 062 479

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Description

Field of Invention

The present invention relates to slip control sheetings with a structured surface and articles, e.g., gymnastic apparatuses and handles of tools, mallets, racquets, baseball bats, golf clubs, and sport sticks, with such sheeting applied thereto.

Background

Gymnastic apparatuses such as pommel horses are typically covered with leather covers. Because such covers are usually somewhat slippery when new, they are typically conditioned by roughening with scouring pads, wire brushes, knives, etc. Scouring is typically done by hand with a circular motion resulting in a visible pattern of swirls on the surface. Conditioning in this fashion entails cutting and gouging the surface of the cover, tending to result in shortened life of the cover, making it necessary to have the apparatus recovered periodically.

Gymnasts frequently apply chalk to their hands when practicing and during performances. This chalk builds up on the cover of the apparatus, filling in the texture and leaving a smooth, somewhat hard surface that must be brushed or sanded to remove the chalk. Because of the pattern of swirls and rough texture of a hand-conditioned cover, it is difficult to remove chalk as desired. In addition to chalk, such substances as KARO Brand Corn Syrup, pine tar, and spray adhesive are sometimes used by gymnasts to improve their grip to conventional covers.

In light of these conditions, conventional gymnastic apparatus covers, which cost several hundred dollars, may wear out after relatively short periods, presenting substantial costs to schools and other gymnasium operators. Also, surface conditioning practices and uneven wear may impart substantially non-uniform characteristics to a cover, presenting potentially unsafe conditions to a gymnast as seemingly similar portions of a cover may exhibit substantially different properties. In some cases, falls may lead to serious injuries such as broken bones and paralysis. The need for higher grip surfaces for gymnastics apparatuses has been known for a long time.

Because the handles of many tools, mallets, racquets, golf clubs and sport sticks have leather grips, some of the same problems associated with the use of leather covers for gymnastic apparatuses are also encountered during use of these handles. For example, the leather grips can be slippery when new. Perhaps more importantly, the leather grips tend to become impregnated with perspiration during use of the grips, causing the grips to become more slippery with increasing use. Of course, this can result in reduced gripping of the handle and a consequent drop in safety and performance potential. For this reason, users of leather gripped handles often apply chalk or tacky substances to the grips to improve their gripping. The repeated cycles of impregnation of the leather grip with perspiration and subsequent drying in the periods when the grip is not being used, combined with natural aging, result in rapid drying of the leather grip, which loses its softness and must be replaced. Further, if chalk or tacky substances are applied to the leather grip, there may be a tendency for these materials to build up on the grip and further reduce the life of the grip.

In light of the above drawbacks associated with the use of leather grips, some people have substituted rubber or plastic grips for the leather grips. These substitute grips have some advantages over leather grips since they tend to resist perspiration impregnation, can be easier to dry, may not age as quickly, and may be washable. However, the need for better gripping characteristics has remained.

U.S. Patent No. 3,585,101 (Stratton et al.) discloses a material comprising a film having a knurled pattern, e.g., a series of ridges, on one surface and an adhesive layer on the opposite surface. U.S. Patent No. 4,488,918 (Jofs) discloses a plastic film having a non-slip surface comprising spaced random patterns of rigid peaks and ridges formed of a second thermoplastic layer coextruded with and bonded to the plastic film. European Patent Application No. 81830005.5, Publication No. 033,301 (Gibello) discloses handle coverings for tennis racquets and the like which comprise sleeves with relief patterns for a good grip. U.K. Patent No. 2,057,894 (Sasaki) discloses a tape for grips of game and sports appliances, e.g., racquets.

Document FR-A-2,125,305 discloses anti-slip garments comprising a textile material, typically rough, that has braking elements protruding therefrom. The braking elements can be in the form of cylindrical or conical projections or truncated cones, pyramids, or fractions of a sphere. The braking elements can be inserted in the sports garment in the form of strips or pieces or can be permanently placed in certain spots on the garment by, for example, sewing, riveting, glueing, or vulcanization operations. Document DE-A-28 07 658 discloses a sports glove, especially for use by goalkeepers, comprising an elastic lining material and a multi-level profile of nub-shaped or otherwise designed elevations protruding from a base plane of the elastic lining material as well as circular or rectangular recesses provided in the base plane. The multi-level profile typically takes the form of at least three levels lying in different planes. Document DE-A-32 03 023 discloses a sports glove, especially for use by goalkeepers, comprising correspondingly shaped inner and outer palm linings, wherein the inner palm lining is provided on its outside with a contact-fastening layer that is adapted to be detachably mated with a fleece layer provided on the inside of the outer palm lining.

Summary of the Invention

According to the present invention there is provided a slip control sheeting comprising a backing having a first and a second major surface and an array of protrusions on said first major surface, characterized in that said protrusions have a height of between 75 and 750 μm, said protrusions comprise at least one of pyramids with polygonal bases or pyramidal frustums with polygonal bases, said array is defined in part by a pattern of intersecting sets of parallel grooves formed in said first major surface, which grooves define major axes of said sheeting, and at least one of the following:

a) said sheeting comprises at least one of a layer of adhesive on said second major surface, a reinforcing web, or a mechanical fastening component for fastening said backing to a substrate; and
b) said sheeting retroreflects less than 10 percent of a beam of electromagnetic radiation which is incident at any angle to said second major surface, the electromagnetic radiation having any wavelength from 0.39 μm to 1,000 μm.

Optional features of the invention are set out in claims 2 to 10 below.

The sheeting may be applied to articles which are adapted for interaction with hands or feet, such as gymnastic stations particularly for example a pommel horse, athletic equipment, tools and mallets.

Among the many advantages that can be provided by this invention are that articles to which sheetings of the invention have been applied exhibit more uniform and more consistent slip control properties, thereby enhancing their safe, convenient, and effective use. Also, articles such as gymnastic equipment covered with sheetings of the invention exhibit improved durability, retention of more uniform slip properties over entire service life time, and more consistent slip properties over the entire apparatus. Sheetings of the invention may be applied to new or older gymnastic equipment.

Brief Description of Drawing

The invention will be further explained with reference to the drawing, wherein:

Figure 1 is a cross-section of a portion of an illustrative slip control sheeting of the invention;
Figure 2 is a plan view of a portion of the first major surface of an illustrative slip control sheeting of the invention;
Figure 3 is a side view of a gymnastic station to which a sheeting of the invention has been applied;
Figure 4 is a graphical illustration of the paths of motion of the hands of illustrative gymnasts performing handspring full vaults using a horse with a conventional cover;
Figure 5 is a graphical illustration of the paths of motion of the hands of illustrative gymnasts performing handspring full vaults using a horse covered with an illustrative slip control sheeting of the invention;
Figure 6 is a graphical illustration of the resultant speed of the gymnasts in the vaults shown in Figure 4; and
Figure 7 is a graphical illustration of the resultant speed of the gymnasts in the vaults shown in Figure 5.

Figures 1-3 are idealized and are not to scale.

Detailed Description of Illustrative Embodiments

Figure 1 illustrates an illustrative slip control sheeting of the invention 10 comprising backing 12 having first major surface 14 and second major surface 16 and optional adhesive layer 18 on second major surface 16. First major surface 14 and second major surface 16 are typically generally planar. Adhesive layer 18 will typically be covered by optional release liner 20 during shipping and storage of sheeting 10. First major surface 14 bears an array (i.e., an orderly arrangement such as a regularly repeating pattern) of protrusions 22 thereon. Protrusions 22 may be discrete elements laminated to backing 12 or may be integral parts of backing 12, i.e., backing 12 may be structured in the form of protrusions 22.

In a first embodiment of the invention, protrusions 22 comprise pyramidal protrusions, i.e., pyramids with polygonal bases or pyramidal frustums with polygonal bases. Each polygonal base is disposed on first major surface 14 of backing 12 and is defined by a plurality of line segments which lie in or on the plane of first major surface 14.

The polygonal bases of protrusions 22 are preferably selected from the group consisting of triangular bases, quadrilateral bases, pentagonal bases, hexagonal bases, heptagonal bases, octagonal bases, nonagonal bases and decagonal bases. In a most preferred form of the first embodiment, as shown in Figures 1 and 2, protrusions 22 are triangular pyramids, i.e., three-sided pyramids having triangular bases. As shown in Figure 2, the polygonal bases of protrusions 22 are typically immediately adjacent one another such that there is no land separating the polygonal bases.

The line segments defining the sides of the polygonal base of each pyramidal protrusion are preferably relatively equal in length, but need not be. By relatively equal, it is meant that the length of the shortest line segment is equal to at least about 50 percent of the length of the longest line segment. Most preferably, the line segments defining the sides of the polygonal base of each pyramidal protrusion are equal in length. Each line segment is typically between 5 and 75 mils (125 and 1,875 μm), but preferably is between 5 and 30 mils (125 and 750 μm), and most preferably between 10 and 20 mils (250 and 500 μm), in length.

In the illustrative embodiment shown in Figure 2, a pattern of three intersecting sets of parallel v-shaped grooves yields the structured surface. The apexes of each set of grooves are identified as a, b, and c. The base of each individual protrusion 22 is defined by one groove of each of the three sets. As mentioned above, the three sides of the base of each three-sided pyramid are typically relatively equal in length. This can be controlled by selection of the intersection angles between the three sets of grooves, i.e., angles alpha, beta, and gamma. Each side of the base of a pyramidal protrusion and the peak of that protrusion defines a plane, referred to herein as a face of the protrusion. The faces of each protrusion are preferably relatively equal in area.

The direction parallel to each set of grooves is referred to herein as a major axis of the sheeting. Thus, the sheeting shown in Figure 2 has three major axes. We have found that the maximum grip or friction provided by sheeting of the invention is obtained in a direction perpendicular to one of the major axes of the sheeting. In some instances, sheetings of the invention are characterized as having directional gripping characteristics.

With respect to sheetings of the invention in general, if the protrusions comprise pyramidal or conical frustums, each frustum typically has a planar top or upper surface which is parallel to its base, although it is contemplated that the planar top or upper surface of the frustum can be inclined at an angle relative to the frustum's base. Further, the tops or upper surfaces of the frustums are not necessarily planar.

If a sheeting of the invention comprises pyramids or cones, it is typically preferred, but not essential, that the peak of the pyramid or cone be centered over the geometric center of the base of the pyramid or cone. If a sheeting of the invention comprises pyramidal or conical frustums, it is preferred, but not essential, that the planar tops of the frustums have geometric centers which are centered over the geometric centers of their respective bases. In some instances, if the protrusions of a sheeting have peaks or planar tops which are "horizontally offset" from their respective bases, the sheeting may have directional gripping characteristics as a result. Sheetings having directional gripping characteristics would likely be considered desirable in many envisioned applications.

With respect to either embodiment of the invention, the protrusions are typically between 3 mils and 21 mils (75 and 525 μm), preferably between 5 mils and 9 mils (125 and 225 μm), and most preferably 7 mils (175 μm), in height. In some embodiments, sheetings of the invention can comprise protrusions up to 30 mils (750 μm) in height, although such sheetings may tend to be abrasive to one's skin. As used herein and shown in Figure 1, the height h of a protrusion refers to the length of the shortest possible line segment extending from the protrusion's peak P to its base. The protrusion's peak is defined to be the highest point of the protrusion, i.e., the point of the protrusion located furthest from the plane in which first major surface 14 lies.

The shape of a protrusion is characterized by its aspect ratio, which is defined as the ratio of the protrusion's height h to its equivalent base diameter D_{eq}. Where the base of the protrusion is a circle, the equivalent base diameter D_{eq} is simply the diameter of the circle. Where the base of the protrusion is not a circle, the equivalent base diameter D_{eq} is defined as the diameter of a hypothetical circle having the same area as the base. It is believed that the invention can be practiced satisfactorily if the protrusions have an aspect ratio which is from about 0.1 to about 5. Most preferably, the aspect ratio for pyramidal protrusions is from about 0.3 to about 0.6.

Backing 12 typically comprises a polymeric film selected from, for example, the group consisting of polyvinyls, polyurethanes, polyesters, e.g., polyethylene terephthalate, polyacrylics, polycarbonates, polyolefins, and mixtures thereof. Polyurethanes are presently preferred because they typically yield slip control sheetings which offer an optimum combination of high toughness and durability coupled with high softness and flexibility. Polyacrylics typically yield slip control sheetings that are relatively rigid. Further, the backing can be a solid film or a foamed film.

Backing 12, excluding the height of the protrusions, is typically between 2 mils and 100 mils (50 and 2,500 μm) thick, and most preferably between 4 mils and 20 mils (100 and 500 μm) thick. Referring again to Figure 1, the sheeting of the invention can include optional release liner 20 and optional adhesive layer 18, adhesive layer 18 typically comprising an adhesive selected to provide a strong bond to the substrate article to which the resultant sheeting is to be applied. For example, heat-activated adhesives, pressure-sensitive adhesives, and mixtures thereof can be used. An illustrative example of a useful adhesive is Adhesive Transfer Tape 950 from Minnesota Mining and Manufacturing Company. Many suitable epoxy, urethane, and acrylic adhesives are commercially available.

However, sheetings of the invention need not include adhesive layer 18 or release liner 20. For instance, the sheeting of the invention can alternatively comprise a reinforcing web, e.g., a sheet of fabric, or a mechanical fastening component for fastening the backing to a substrate. Further, sheetings of the invention can include combinations of two or more of the above. Sheetings having a reinforcing web are considered especially useful when it is desired to sew the sheeting to a substrate.

If the sheeting comprises a reinforcing web, backing 12 will in some instances be sufficiently thick to embed the web therein. Alternatively, the web can merely be suitably secured to second major surface 16 of backing 12. Embedded webs can impart increased tear resistance and tensile strength, enabling the slip control sheeting to be attached to a substrate via sewing more effectively. Also, in cases where the web protrudes from second major surface 16 of backing 12, the web can provide an increased surface area, thereby improving the bond to an adhesive layer or substrate.

If the sheeting of the invention comprises a mechanical fastening component for fastening the backing to a substrate, the mechanical fastening component can take the form of a plurality of hooks or a plurality of loops disposed on second major surface 16, the hooks or loops constituting part of a hook and loop type fastening system, e.g., a VELCRO Brand fastener.

Most preferably, the mechanical fastening component would take the form of a structured surface which includes a plurality of tapered elements. Each tapered element can comprise a side which is inclined relative to the plane of the structured surface at an angle sufficient to form a taper. With such a construction, each tapered element is adapted to mate through a frictional or torsional force of adherence with at least one corresponding element of a complementarily structured surface of a substrate. An example of a mechanical fastening component which utilizes a frictional force of adherence is disclosed in U.S. Patent No. 4,875,259 (Appeldorn). A torsional force of adherence can be effected if at least one of the tapered elements of the structured surface of the sheeting or the complementarily structured surface of the substrate can be axially bent or torsionally flexed relative to its relaxed, unfastened position. This permits the sheeting to be fastened with a substrate in a random alignment.

In some instances, the protrusions of the sheeting may be made of a first, relatively hard and highly durable material, and the backing may be made of a relatively more flexible material. Further, the material of the protrusions can comprise an abrasive or other fillers. Although the protrusions preferably comprise a substantially solid material, it is contemplated that the protrusions can be made of foam. Further, all or a portion of each protrusion can be filled with a fluid, e.g., a gas such as air or nitrogen. If a gas were used, the pressure of the gas within each protrusion would have to be selected to provide the protrusions with the desired amount of compressibility.

Properly constructed sheetings of the invention generally exhibit a combination of high durability and friction due to the coupling of hard protrusions (e.g., polycarbonate), which are typically substantially incompressible and non-collapsible, with a more conformable, flexible backing material (e.g., polyurethane) that results in a more cushioned impact during use. Typically, a sheeting of the invention is sufficiently flexible to be wound about itself on a 1 inch (2.54 cm) diameter mandrel.

Some embodiments of sheetings of the invention can be made using techniques which are somewhat similar to those used to make cube-corner retroreflective sheetings. It will be understood, however, that a sheeting of the invention can be made of a substantially non-retroreflective material such as a substantially opaque or translucent material if desired, and can even be made in a variety of colors if desired. For example, referring to Figure 1, sheeting 10 can be made such that it will retroreflect less than about 10 percent of a beam of electromagnetic radiation which is incident at any angle to second major surface 16, the electromagnetic radiation having any wavelength within the visible light or infrared radiation regions, i.e., wavelengths ranging from about 0.39 microns to about 1,000 microns. Thus, at least a portion of sheeting 10 can have a structure similar to retroreflective sheetings, but need not be retroreflective. This means that sheeting 10 can be made of less expensive materials because optical performance is not a concern. Further, sheeting 10 need not necessarily be manufactured in as precise a manner as retroreflective sheetings of the prior art since optical performance is not needed.

A sheeting of the invention may be formed by cutting a series of v-shaped grooves into a solid sheeting, molding a sheeting with the desired protrusions thereon, or molding protrusions and then applying them to a desired backing sheet. Many of the techniques used for fabricating cube-corner retroreflective sheeting may be used to form slip control sheets of the invention, with the important advantage that the optical properties critical to retroreflective sheetings are not necessary for sheets of the invention. U.S. Patent No. 4,576,850 (Martens), discloses a process for replicating microstructured surfaces that may be used in making sheetings of the invention. U.S. Patent No. 3,689,346 (Rowland) also discloses a method comprising applying a hardenable molding material over a mold having a multiplicity of cube-corner formations therein.

Illustrative examples of gymnastic apparatuses or stations to which sheetings of the invention may be applied include vaulting horses, pommel horses, parallel bars, uneven bars, high bars, balance beams, vault spring boards, vault runways, still rings and landing mats. Figure 3 illustrates vaulting horse 100 with body 102 on legs 104. A slip control sheeting 10 has been applied to surface 106.

Desired flexibility, elasticity, and conformability of the sheeting is dependent in part upon the station to which it is to be applied. For instance, in the case of the balance beam, vaulting horse, pommel horse, vault spring board and landing mats, the sheeting should be somewhat elastic and conformable so as to give or compress under pressure of the gymnasts' hands and/or feet. During use, the parallel bars, uneven bars, and high bar do not compress in this fashion but they typically flex. Accordingly, a sheeting of the invention for use thereon should be flexible.

Sheetings of the invention may be applied to the handles of such athletic equipment as baseball bats, golf clubs, and tennis, racquetball, squash, and badminton racquets. If desired, sheetings of the invention may be applied to the gripping surfaces of gloves to improve the grip obtained with conformable surfaces, e.g., rubber or foam-covered bats or water ski handles. Sheetings of the invention may be applied to the handles of mallets or tools such as hammers, pliers, wire cutters, screw drivers, wrenches, etc.

Sheetings of the invention may be used with bars provided in rest rooms for handicapped persons or railings in stairwells as they are a convenient means for providing secure, effective slip control and readily cleaned or washed surfaces. They may also be applied to such articles as diving boards and the areas around swimming pools. Further, sheetings of the invention can be applied to the support surfaces of eye glasses, especially the support surfaces which come in contact with the wearer's nose.

In general, a slip control sheeting of the invention can be secured to a surface of an article which is adapted for interaction with hands or feet to impart favorable slip control properties to the surface. It is contemplated that such articles would include articles adapted to be manipulated by one's hand, such as hammers, as well as articles which provide secure footing, such as shower mats.

Examples

The invention will be further explained by the following illustrative examples

Two resident male gymnastic athletes at the Olympic Training Center in Colorado Springs, Colorado, regional finalists for the Senior National Team, were videotaped using a high speed video camera, NAC HSV-44, operating at 400 frames/second while performing two handspring full vaults each on two different vaulting horses. The vaulting horses were substantially identical except that Horse A was covered with a conventional plasticized polyvinyl chloride cover that was about 1 year old and Horse B was covered with a slip control sheeting comprising a 10 mil (250 μm) thick polyurethane backing with polyurethane protrusions thereon. The protrusions were three-sided pyramids about 7 mils (175 μm) in height formed from a master made by cutting v-shaped grooves, with angles alpha and beta equal to about 55° and angle gamma equal to about 70°. The grooves in set a were spaced about 14 mils (355 μm) apart, the grooves in set b were spaced about 16 mils (410 μm) apart, and those in set c were spaced about 16 mils (410 μm) apart.

Each gymnast wore a reflective target on the outside of his right hand near the proximal head of the fifth metacarpal. Digital analysis was performed using the Peak Performance Video and Analog Motion Measurement System from Peak Performance Technologies, Inc., Englewood, Colorado, U.S.A. The video digitizing/playback system employed a Panasonic AG-7300 video cassette recorder, a Sony Trinitron monitor, and an IBM-compatible computer. Coordinate data was smoothed using a low-pass, fourth order, zero lag Butterworth digital filter with a cutoff frequency of 5 Hertz. Smoothed coordinate data were used to calculate displacement and velocity parameters.

Table I contains the displacement results from Horse A. This information is shown graphically in Figure 4. Table II contains the displacement results from Horse B. This information is shown graphically in Figure 5.

Table III contains the resultant velocities for vaults 1 and 2 on Horse A. Table IV contains the resultant velocities for vaults 3 and 4 on Horse A. This information is shown graphically in Figure 6.

Table V contains the resultant velocities for vaults 1 and 2 on Horse B. Table VI contains the resultant velocities for vaults 3 and 4 on Horse B. This information is shown graphically in Figure 7.

TABLE I

Displacement Data: Horse A

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
-0.1050	-0.296	0.144	-0.340	0.136	-0.301	0.208	-0.245	0.091
-0.1025	-0.285	0.139	-0.330	0.133	-0.293	0.204	-0.235	0.087
-0.1000	-0.274	0.134	-0.320	0.129	-0.284	0.200	-0.225	0.083
-0.0975	-0.263	0.129	-0.310	0.126	-0.276	0.196	-0.215	0.080
-0.0950	-0.253	0.124	-0.300	0.123	-0.267	0.192	-0.205	0.076
-0.0925	-0.242	0.119	-0.290	0.119	-0.258	0.187	-0.195	0.072
-0.0900	-0.232	0.114	-0.280	0.116	-0.249	0.182	-0.185	0.068
-0.0875	-0.222	0.109	-0.270	0.112	-0.240	0.178	-0.176	0.065
-0.0850	-0.213	0.104	-0.260	0.108	-0.230	0.173	-0.166	0.061
-0.0825	-0.204	0.099	-0.250	0.104	-0.221	0.168	-0.156	0.057
-0.0800	-0.195	0.094	-0.240	0.100	-0.211	0.162	-0.147	0.053
-0.0775	-0.186	0.089	-0.230	0.096	-0.202	0.157	-0.138	0.049
-0.0750	-0.178	0.085	-0.220	0.092	-0.193	0.152	-0.128	0.046
-0.0725	-0.170	0.080	-0.210	0.087	-0.183	0.146	-0.120	0.042
-0.0700	-0.162	0.076	-0.200	0.083	-0.174	0.141	-0.111	0.038
-0.0675	-0.155	0.072	-0.190	0.078	-0.165	0.135	-0.102	0.035
-0.0650	-0.148	0.067	-0.180	0.074	-0.156	0.129	-0.094	0.031
-0.0625	-0.141	0.063	-0.170	0.069	-0.147	0.123	-0.086	0.028
-0.0600	-0.134	0.059	-0.160	0.064	-0.139	0.117	-0.078	0.025
-0.0575	-0.128	0.055	-0.160	0.060	-0.130	0.111	-0.071	0.022
-0.0550	-0.121	0.051	-0.150	0.055	-0.122	0.105	-0.064	0.019
-0.0525	-0.115	0.047	-0.140	0.050	-0.114	0.099	-0.058	0.017
-0.0500	-0.109	0.043	-0.130	0.046	-0.106	0.093	-0.051	0.014
-0.0475	-0.103	0.040	-0.130	0.042	-0.099	0.087	-0.045	0.012
-0.0450	-0.097	0.036	-0.120	0.037	-0.091	0.082	-0.040	0.010
-0.0425	-0.091	0.033	-0.110	0.033	-0.084	0.076	-0.035	0.009
-0.0400	-0.085	0.029	-0.100	0.029	-0.078	0.070	-0.030	0.007
-0.0375	-0.079	0.026	-0.100	0.026	-0.071	0.064	-0.025	0.006
-0.0350	-0.073	0.023	-0.090	0.023	-0.065	0.058	-0.021	0.005
-0.0325	-0.067	0.020	-0.080	0.020	-0.058	0.053	-0.018	0.004
-0.0300	-0.061	0.018	-0.080	0.017	-0.053	0.047	-0.015	0.003
-0.0275	-0.055	0.015	-0.070	0.014	-0.047	0.042	-0.012	0.003
-0.0250	-0.049	0.013	-0.060	0.012	-0.041	0.037	-0.009	0.002
-0.0225	-0.044	0.011	-0.060	0.010	-0.036	0.032	-0.007	0.002
-0.0200	-0.038	0.009	-0.050	0.008	-0.031	0.028	-0.005	0.002

TABLE I cont.

Displacement Data: Horse A

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
-0.0175	-0.033	0.008	-0.040	0.007	-0.027	0.023	-0.004	0.001
-0.0150	-0.028	0.006	-0.040	0.005	-0.022	0.019	-0.003	0.001
-0.0125	-0.023	0.005	-0.030	0.004	-0.018	0.015	-0.002	0.001
-0.0100	-0.018	0.004	-0.030	0.003	-0.014	0.012	-0.001	0.001
-0.0075	-0.013	0.003	-0.020	0.002	-0.010	0.008	0.000	0.001
-0.0050	-0.009	0.002	-0.010	0.002	-0.006	0.005	0.000	0.001
-0.0025	-0.004	0.001	-0.010	0.001	-0.003	0.002	0.000	0.000
0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.0025	0.004	-0.001	0.010	0.000	0.004	-0.003	0.000	0.000
0.0050	0.007	-0.001	0.010	-0.001	0.006	-0.005	0.000	0.000
0.0075	0.011	-0.002	0.020	-0.002	0.009	-0.007	0.000	0.000
0.0100	0.014	-0.002	0.020	-0.002	0.012	-0.009	-0.001	0.000
0.0125	0.017	-0.003	0.030	-0.003	0.015	-0.011	-0.001	0.000
0.0150	0.019	-0.003	0.040	-0.003	0.017	-0.013	-0.001	0.000
0.0175	0.022	-0.004	0.040	-0.004	0.019	-0.015	-0.002	0.000
0.0200	0.024	-0.004	0.050	-0.005	0.022	-0.016	-0.002	0.000
0.0225	0.026	-0.004	0.060	-0.005	0.024	-0.018	-0.003	0.000
0.0250	0.028	-0.005	0.060	-0.006	0.026	-0.019	-0.003	0.000
0.0275	0.029	-0.005	0.070	-0.007	0.028	-0.021	-0.003	0.000
0.0300	0.030	-0.005	0.080	-0.007	0.031	-0.022	-0.004	0.000
0.0325	0.031	-0.006	0.080	-0.008	0.033	-0.023	-0.004	0.000
0.0350	0.032	-0.006	0.090	-0.009	0.035	-0.025	-0.005	0.000
0.0375	0.033	-0.006	0.090	-0.010	0.036	-0.026	-0.005	0.001
0.0400	0.033	-0.007	0.100	-0.010	0.038	-0.027	-0.005	0.001
0.0425	0.034	-0.007	0.100	-0.011	0.040	-0.028	-0.006	0.001
0.0450	0.034	-0.007	0.110	-0.012	0.041	-0.029	-0.006	0.002
0.0475	0.034	-0.007	0.110	-0.013	0.043	-0.029	-0.006	0.002
0.0500	0.034	-0.007	0.110	-0.014	0.044	-0.030	-0.006	0.003
0.0525	0.034	-0.007	0.120	-0.015	0.045	-0.031	-0.006	0.003
0.0550	0.034	-0.007	0.120	-0.016	0.046	-0.031	-0.006	0.004
0.0575	0.034	-0.008	0.120	-0.017	0.047	-0.032	-0.006	0.005
0.0600	0.034	-0.008	0.120	-0.018	0.048	-0.032	-0.006	0.006
0.0625	0.034	-0.008	0.120	-0.019	0.048	-0.032	-0.006	0.007
0.0650	0.034	-0.008	0.130	-0.020	0.048	-0.032	-0.005	0.008
0.0675	0.033	-0.008	0.130	-0.022	0.049	-0.032	-0.005	0.010
0.0700	0.033	-0.008	0.130	-0.023	0.049	-0.032	-0.004	0.011
0.0725	0.033	-0.008	0.120	-0.025	0.049	-0.032	-0.004	0.013
0.0750	0.033	-0.007	0.120	-0.026	0.049	-0.032	-0.003	0.015
0.0775	0.033	-0.007	0.120	-0.028	0.049	-0.031	-0.002	0.016
0.0800	0.033	-0.007	0.120	-0.029	0.048	-0.031	-0.001	0.018

TABLE I cont.

Displacement Data: Horse A

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
0.0825	0.033	-0.007	0.120	-0.031	0.048	-0.030	0.000	0.021
0.0850	0.033	-0.007	0.120	-0.032	0.048	-0.029	0.001	0.023
0.0875	0.033	-0.006	0.110	-0.034	0.048	-0.028	0.002	0.026
0.0900	0.032	-0.006	0.110	-0.035	0.047	-0.028	0.004	0.028
0.0925	0.032	-0.006	0.110	-0.036	0.047	-0.027	0.005	0.031
0.0950	0.032	-0.005	0.100	-0.037	0.047	-0.026	0.007	0.034
0.0975	0.032	-0.005	0.100	-0.038	0.046	-0.024	0.008	0.036
0.1000	0.032	-0.004	0.090	-0.039	0.046	-0.023	0.010	0.039
0.1025	0.032	-0.004	0.090	-0.039	0.046	-0.022	0.012	0.042
0.1050	0.032	-0.003	0.090	-0.039	0.046	-0.020		
0.1075	0.032	-0.002	0.080	-0.039	0.045	-0.018		
0.1100	0.032	-0.002	0.080	-0.039	0.045	-0.017		
0.1125	0.031	-0.001	0.070	-0.039	0.045	-0.015		
0.1150	0.031	0.000	0.070	-0.038	0.045	-0.013		
0.1175	0.031	0.001	0.060	-0.037	0.045	-0.011		
0.1200	0.031	0.002	0.060	-0.036	0.045	-0.008		
0.1225	0.031	0.003	0.050	-0.034	0.045	-0.006		
0.1250	0.031	0.004	0.050	-0.032	0.045	-0.004		
0.1275	0.032	0.005	0.040	-0.030	0.045	-0.001		
0.1300	0.032	0.006	0.040	-0.028	0.045	0.002		
0.1325	0.032	0.008	0.030	-0.026	0.045	0.005		
0.1350	0.032	0.009	0.030	-0.023	0.045	0.007		
0.1375	0.032	0.010	0.020	-0.020	0.046	0.010		
0.1400	0.032	0.012	0.020	-0.017	0.046	0.014		
0.1425	0.033	0.013	0.020	-0.014	0.046	0.017		
0.1450	0.033	0.014	0.010	-0.010	0.046	0.020		
0.1475			0.010	-0.007	0.046	0.024		
0.1500			0.000	-0.003	0.047	0.027		
0.1525			0.000	0.000	0.047	0.031		
0.1550			-0.010	0.004	0.047	0.034		
0.1575			-0.010	0.008	0.047	0.038		
0.1600					0.047	0.042		
0.1625					0.047	0.045		
0.1650					0.047	0.049		
0.1675					0.047	0.053		

TABLE II

Displacement Data: Horse B

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
-0.1050	-0.162	0.107	-0.171	0.120	-0.103	0.076	-0.138	0.089
-0.1025	-0.153	0.101	-0.161	0.115	-0.096	0.070	-0.129	0.084
-0.1000	-0.143	0.096	-0.151	0.110	-0.089	0.065	-0.121	0.079
-0.0975	-0.135	0.090	-0.141	0.104	-0.083	0.059	-0.112	0.074
-0.0950	-0.126	0.084	-0.131	0.099	-0.076	0.054	-0.104	0.069
-0.0925	-0.117	0.079	-0.122	0.093	-0.070	0.049	-0.096	0.065
-0.0900	-0.109	0.073	-0.112	0.088	-0.064	0.044	-0.088	0.060
-0.0875	-0.101	0.068	-0.103	0.082	-0.058	0.040	-0.081	0.055
-0.0850	-0.093	0.062	-0.094	0.077	-0.053	0.035	-0.073	0.050
-0.0825	-0.086	0.057	-0.086	0.071	-0.048	0.031	-0.067	0.046
-0.0800	-0.078	0.052	-0.078	0.066	-0.043	0.028	-0.060	0.042
-0.0775	-0.071	0.047	-0.070	0.060	-0.038	0.024	-0.054	0.037
-0.0750	-0.065	0.042	-0.062	0.055	-0.034	0.021	-0.048	0.033
-0.0725	-0.058	0.037	-0.055	0.050	-0.030	0.018	-0.042	0.030
-0.0700	-0.052	0.033	-0.049	0.045	-0.026	0.015	-0.037	0.026
-0.0675	-0.046	0.029	-0.043	0.040	-0.022	0.013	-0.032	0.023
-0.0650	-0.041	0.025	-0.037	0.035	-0.019	0.011	-0.028	0.020
-0.0625	-0.036	0.021	-0.032	0.031	-0.016	0.009	-0.024	0.017
-0.0600	-0.031	0.018	-0.027	0.027	-0.014	0.007	-0.020	0.014
-0.0575	-0.027	0.015	-0.023	0.023	-0.012	0.006	-0.017	0.012
-0.0550	-0.023	0.012	-0.019	0.019	-0.010	0.005	-0.014	0.010
-0.0525	-0.019	0.010	-0.016	0.016	-0.008	0.004	-0.011	0.008
-0.0500	-0.016	0.008	-0.013	0.013	-0.006	0.003	-0.009	0.007
-0.0475	-0.013	0.006	-0.010	0.011	-0.005	0.002	-0.007	0.005
-0.0450	-0.010	0.005	-0.008	0.009	-0.004	0.002	-0.005	0.004
-0.0425	-0.008	0.004	-0.006	0.007	-0.003	0.001	-0.004	0.003
-0.0400	-0.006	0.003	-0.005	0.005	-0.002	0.001	-0.003	0.002
-0.0375	-0.005	0.002	-0.004	0.004	-0.002	0.001	-0.002	0.002
-0.0350	-0.003	0.001	-0.003	0.003	-0.001	0.000	-0.001	0.001
-0.0325	-0.002	0.001	-0.002	0.002	-0.001	0.000	0.000	0.001
-0.0300	-0.001	0.000	-0.001	0.001	-0.001	0.000	0.000	0.000
-0.0275	-0.001	0.000	-0.001	0.001	0.000	0.000	0.000	0.000
-0.0250	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
-0.0225	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-0.0200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE II cont.

Displacement Data: Horse B

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
-0.0175	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
-0.0150	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
-0.0125	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
-0.0100	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000
-0.0075	-0.001	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000
-0.0050	-0.001	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000
-0.0025	-0.002	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000
0.0000	-0.002	0.000	-0.003	0.000	-0.001	0.000	-0.001	0.000
0.0025	-0.002	0.000	-0.003	0.000	-0.001	0.000	-0.001	0.000
0.0050	-0.003	0.000	-0.004	0.000	-0.002	0.000	-0.001	0.000
0.0075	-0.003	0.000	-0.004	0.001	-0.002	0.000	-0.001	0.000
0.0100	-0.004	0.000	-0.004	0.001	-0.002	0.000	-0.001	0.000
0.0125	-0.004	0.000	-0.005	0.001	-0.002	0.000	-0.001	0.000
0.0150	-0.004	0.000	-0.005	0.001	-0.003	0.000	-0.001	0.000
0.0175	-0.005	0.000	-0.005	0.002	-0.003	0.000	-0.001	0.001
0.0200	-0.005	0.000	-0.006	0.002	-0.003	0.000	-0.002	0.001
0.0225	-0.005	0.000	-0.006	0.002	-0.003	0.000	-0.002	0.001
0.0250	-0.006	0.000	-0.006	0.003	-0.004	0.000	-0.002	0.001
0.0275	-0.006	0.000	-0.006	0.003	-0.004	0.000	-0.002	0.001
0.0300	-0.006	0.000	-0.006	0.003	-0.004	0.001	-0.002	0.001
0.0325	-0.006	0.001	-0.006	0.004	-0.004	0.001	-0.002	0.001
0.0350	-0.007	0.001	-0.006	0.004	-0.004	0.001	-0.002	0.001
0.0375	-0.007	0.001	-0.006	0.005	-0.004	0.001	-0.002	0.001
0.0400	-0.007	0.001	-0.006	0.005	-0.004	0.002	-0.002	0.002
0.0425	-0.007	0.001	-0.006	0.006	-0.004	0.002	-0.002	0.002
0.0450	-0.007	0.002	-0.006	0.006	-0.004	0.003	-0.002	0.002
0.0475	-0.008	0.002	-0.006	0.007	-0.004	0.003	-0.003	0.002
0.0500	-0.008	0.002	-0.006	0.008	-0.004	0.004	-0.003	0.002
0.0525	-0.008	0.003	-0.006	0.009	-0.004	0.004	-0.003	0.002
0.0550	-0.008	0.003	-0.006	0.009	-0.004	0.005	-0.003	0.003
0.0575	-0.008	0.003	-0.005	0.011	-0.004	0.006	-0.003	0.003
0.0600	-0.008	0.004	-0.005	0.012	-0.004	0.007	-0.003	0.003
0.0625	-0.008	0.004	-0.005	0.013	-0.004	0.008	-0.003	0.003
0.0650	-0.008	0.005	-0.004	0.014	-0.003	0.009	-0.003	0.003
0.0675	-0.008	0.005	-0.004	0.016	-0.003	0.011	-0.003	0.003
0.0700	-0.008	0.006	-0.003	0.017	-0.002	0.012	-0.002	0.004
0.0725	-0.008	0.006	-0.003	0.019	-0.002	0.014	-0.002	0.004
0.0750	-0.008	0.007	-0.002	0.021	-0.001	0.016	-0.002	0.005
0.0775	-0.008	0.008	-0.002	0.024	-0.001	0.018	-0.002	0.005
0.0800	-0.008	0.009	-0.001	0.026	0.000	0.020	-0.001	0.006

TABLE II cont.

Displacement Data: Horse B

Units: meters

	Vault #1		Vault #2		Vault #3		Vault #4	
time (sec)	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.	x displ.	y displ.
0.0825	-0.008	0.010	-0.001	0.028	0.001	0.023	-0.001	0.007
0.0850	-0.008	0.011	0.000	0.031	0.001	0.025	-0.001	0.007
0.0875	-0.007	0.012	0.000	0.034	0.002	0.028	0.000	0.009
0.0900	-0.007	0.014	0.001	0.037	0.003	0.031	0.000	0.010
0.0925	-0.007	0.015	0.001	0.040	0.004	0.034	0.001	0.011
0.0950	-0.006	0.017	0.002	0.043	0.005	0.037	0.002	0.013
0.0975	-0.006	0.019	0.002	0.046	0.006	0.040	0.002	0.015
0.1000	-0.005	0.021	0.003	0.050	0.007	0.044	0.003	0.016
0.1025	-0.005	0.023	0.004	0.053	0.008	0.047	0.004	0.019
0.1050	-0.004	0.026	0.004	0.057	-0.001	0.016	0.005	0.021
0.1075	-0.004	0.028	0.005	0.060	-0.001	0.018	0.006	0.024
0.1100	-0.003	0.031			0.000	0.020	0.007	0.027
0.1125	-0.002	0.033			0.001	0.023	0.009	0.030
0.1150	-0.002	0.036			0.001	0.025	0.010	0.033
0.1175	-0.001	0.039			0.002	0.028	0.012	0.037
0.1200	-0.001	0.042			0.003	0.031	0.013	0.040
0.1225	-0.003	0.031			0.004	0.034	0.015	0.044
0.1250	-0.002	0.033			0.005	0.037	0.016	0.048
0.1275	-0.002	0.036			0.006	0.040	0.018	0.053
0.1300	-0.001	0.039			0.007	0.044	0.019	0.057
0.1325	-0.001	0.042			0.008	0.047	0.002	0.015
0.1350							0.003	0.016
0.1375							0.004	0.019
0.1400							0.005	0.021
0.1425							0.006	0.024
0.1450							0.007	0.027
0.1475							0.009	0.030
0.1500							0.010	0.033
0.1525							0.012	0.037
0.1550							0.013	0.040
0.1575							0.015	0.044
0.1600							0.016	0.048
0.1625							0.018	0.053
0.1650							0.019	0.057

TABLE III

Velocity Data: Horse A

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.1050	4.47	-2.06	4.92	4.04	-1.30	4.24
-0.1025	4.42	-2.05	4.88	4.03	-1.31	4.24
-0.1000	4.36	-2.05	4.82	4.03	-1.32	4.24
-0.0975	4.29	-2.04	4.75	4.02	-1.35	4.24
-0.0950	4.20	-2.02	4.67	4.01	-1.37	4.24
-0.0925	4.11	-2.01	4.57	3.99	-1.41	4.23
-0.0900	4.00	-1.99	4.47	3.96	-1.45	4.22
-0.0875	3.89	-1.97	4.36	3.94	-1.49	4.21
-0.0850	3.76	-1.94	4.24	3.90	-1.54	4.20
-0.0825	3.64	-1.92	4.11	3.87	-1.59	4.18
-0.0800	3.51	-1.89	3.99	3.83	-1.64	4.16
-0.0775	3.38	-1.86	3.86	3.78	-1.68	4.14
-0.0750	3.25	-1.83	3.73	3.73	-1.73	4.11
-0.0725	3.13	-1.79	3.60	3.67	-1.77	4.08
-0.0700	3.00	-1.76	3.48	3.61	-1.81	4.04
-0.0675	2.89	-1.72	3.36	3.54	-1.84	3.99
-0.0650	2.78	-1.68	3.25	3.48	-1.86	3.94
-0.0625	2.69	-1.65	3.15	3.41	-1.88	3.89
-0.0600	2.61	-1.62	3.07	3.33	-1.88	3.83
-0.0575	2.55	-1.59	3.01	3.26	-1.87	3.76
-0.0550	2.51	-1.56	2.96	3.19	-1.85	3.69
-0.0525	2.48	-1.53	2.91	3.12	-1.82	3.61
-0.0500	2.46	-1.49	2.88	3.05	-1.77	3.53
-0.0475	2.44	-1.46	2.84	2.98	-1.72	3.44
-0.0450	2.43	-1.41	2.81	2.92	-1.65	3.35
-0.0425	2.42	-1.36	2.78	2.86	-1.57	3.26
-0.0400	2.41	-1.31	2.74	2.80	-1.47	3.17
-0.0375	2.40	-1.24	2.70	2.75	-1.37	3.07
-0.0350	2.38	-1.17	2.66	2.70	-1.27	2.98
-0.0325	2.36	-1.10	2.61	2.66	-1.16	2.90
-0.0300	2.34	-1.02	2.55	2.62	-1.05	2.82
-0.0275	2.31	-0.93	2.49	2.59	-0.94	2.75
-0.0250	2.27	-0.85	2.42	2.56	-0.84	2.69
-0.0225	2.22	-0.77	2.35	2.54	-0.74	2.64
-0.0200	2.17	-0.69	2.28	2.52	-0.65	2.60
-0.0175	2.11	-0.62	2.20	2.51	-0.57	2.57
-0.0150	2.05	-0.55	2.12	2.50	-0.50	2.55
-0.0125	1.98	-0.49	2.04	2.50	-0.44	2.54
-0.0100	1.91	-0.44	1.96	2.51	-0.39	2.54
-0.0075	1.84	-0.39	1.88	2.51	-0.34	2.54

TABLE III cont.

Velocity Data: Horse A

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.0050	1.76	-0.35	1.80	2.52	-0.31	2.54
-0.0025	1.68	-0.32	1.71	2.54	-0.28	2.55
0.0000	1.60	-0.28	1.62	2.55	-0.26	2.57
0.0025	1.51	-0.25	1.53	2.57	-0.25	2.58
0.0050	1.41	-0.23	1.43	2.58	-0.24	2.59
0.0075	1.32	-0.21	1.33	2.59	-0.23	2.60
0.0100	1.22	-0.19	1.23	2.60	-0.23	2.61
0.0125	1.12	-0.18	1.13	2.60	-0.23	2.61
0.0150	1.02	-0.17	1.03	2.59	-0.24	2.60
0.0175	0.92	-0.16	0.93	2.58	-0.25	2.59
0.0200	0.82	-0.16	0.84	2.55	-0.25	2.56
0.0225	0.72	-0.15	0.74	2.51	-0.26	2.53
0.0250	0.63	-0.15	0.65	2.47	-0.27	2.48
0.0275	0.54	-0.14	0.56	2.40	-0.27	2.42
0.0300	0.45	-0.13	0.47	2.33	-0.28	2.35
0.0325	0.37	-0.13	0.39	2.24	-0.29	2.26
0.0350	0.30	-0.12	0.32	2.14	-0.29	2.16
0.0375	0.23	-0.10	0.25	2.03	-0.30	2.06
0.0400	0.17	-0.09	0.19	1.91	-0.31	1.93
0.0425	0.12	-0.08	0.14	1.77	-0.32	1.80
0.0450	0.07	-0.07	0.10	1.62	-0.34	1.66
0.0475	0.04	-0.06	0.07	1.47	-0.35	1.51
0.0500	0.00	-0.05	0.05	1.30	-0.37	1.35
0.0525	-0.02	-0.04	0.04	1.13	-0.40	1.19
0.0550	-0.04	-0.03	0.05	0.95	-0.42	1.04
0.0575	-0.05	-0.02	0.05	0.76	-0.45	0.88
0.0600	-0.06	-0.02	0.06	0.58	-0.48	0.75
0.0625	-0.06	-0.01	0.06	0.39	-0.51	0.64
0.0650	-0.06	0.00	0.06	0.20	-0.54	0.57
0.0675	-0.06	0.01	0.06	0.02	-0.56	0.56
0.0700	-0.05	0.02	0.05	-0.15	-0.59	0.61
0.0725	-0.05	0.03	0.06	-0.33	-0.61	0.69
0.0750	-0.05	0.04	0.06	-0.49	-0.62	0.79
0.0775	-0.04	0.06	0.07	-0.65	-0.62	0.90
0.0800	-0.04	0.08	0.09	-0.80	-0.62	1.01
0.0825	-0.04	0.10	0.11	-0.94	-0.60	1.12
0.0850	-0.04	0.12	0.13	-1.07	-0.58	1.21
0.0875	-0.04	0.14	0.15	-1.19	-0.54	1.30
0.0900	-0.05	0.16	0.16	-1.29	-0.50	1.38
0.0925	-0.05	0.17	0.18	-1.39	-0.44	1.46

TABLE III cont.

Velocity Data: Horse A

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.0950	-0.05	0.19	0.20	-1.47	-0.37	1.52
0.0975	-0.05	0.20	0.21	-1.55	-0.30	1.58
0.1000	-0.05	0.22	0.23	-1.61	-0.22	1.63
0.1025	-0.05	0.24	0.24	-1.67	-0.13	1.68
0.1050	-0.04	0.25	0.26	-1.72	-0.04	1.72
0.1075	-0.04	0.27	0.28	-1.76	0.05	1.76
0.1100	-0.03	0.29	0.30	-1.79	0.15	1.80
0.1125	-0.02	0.32	0.32	-1.82	0.25	1.84
0.1150	-0.01	0.34	0.34	-1.85	0.35	1.88
0.1175	0.00	0.36	0.36	-1.87	0.46	1.93
0.1200	0.01	0.39	0.39	-1.89	0.56	1.97
0.1225	0.02	0.41	0.42	-1.91	0.66	2.02
0.1250	0.03	0.44	0.44	-1.92	0.76	2.06
0.1275	0.05	0.46	0.47	-1.93	0.86	2.11
0.1300	0.06	0.49	0.49	-1.94	0.95	2.16
0.1325	0.07	0.51	0.52	-1.94	1.04	2.2
0.1350	0.07	0.53	0.54	-1.95	1.12	2.25
0.1375	0.08	0.55	0.55	-1.96	1.19	2.29
0.1400	0.08	0.56	0.57	-1.96	1.26	2.33
0.1425	0.08	0.57	0.58	-1.97	1.32	2.37
0.1450	0.08	0.58	0.58	-1.97	1.37	2.4
0.1475				-1.97	1.42	2.43
0.1500				-1.97	1.45	2.45
0.1525				-1.97	1.47	2.46
0.1550				-1.98	1.49	2.47
0.1575				-1.98	1.5	2.48

TABLE IV

Velocity Data: Horse A

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.1050	3.17	-1.41	3.47	4.00	-1.49	4.27
-0.1025	3.25	-1.48	3.57	4.00	-1.50	4.27
-0.1000	3.34	-1.54	3.68	3.99	-1.50	4.26
-0.0975	3.42	-1.61	3.78	3.98	-1.50	4.25
-0.0950	3.50	-1.68	3.88	3.96	-1.51	4.24
-0.0925	3.57	-1.75	3.98	3.94	-1.51	4.22
-0.0900	3.63	-1.82	4.06	3.92	-1.51	4.20
-0.0875	3.68	-1.88	4.13	3.89	-1.52	4.17
-0.0850	3.71	-1.94	4.19	3.85	-1.52	4.14
-0.0825	3.74	-2.00	4.24	3.80	-1.52	4.09
-0.0800	3.75	-2.05	4.28	3.75	-1.51	4.04
-0.0775	3.76	-2.10	4.30	3.69	-1.50	3.98
-0.0750	3.75	-2.15	4.32	3.61	-1.49	3.91
-0.0725	3.73	-2.19	4.33	3.53	-1.46	3.83
-0.0700	3.70	-2.23	4.32	3.44	-1.43	3.73
-0.0675	3.66	-2.27	4.30	3.34	-1.40	3.62
-0.0650	3.61	-2.30	4.28	3.24	-1.35	3.51
-0.0625	3.55	-2.33	4.24	3.12	-1.29	3.38
-0.0600	3.48	-2.35	4.20	3.00	-1.23	3.24
-0.0575	3.41	-2.37	4.15	2.87	-1.15	3.09
-0.0550	3.33	-2.38	4.09	2.73	-1.07	2.93
-0.0525	3.24	-2.39	4.03	2.59	-0.99	2.77
-0.0500	3.16	-2.40	3.96	2.45	-0.90	2.61
-0.0475	3.07	-2.40	3.89	2.30	-0.80	2.44
-0.0450	2.98	-2.39	3.82	2.15	-0.71	2.26
-0.0425	2.88	-2.38	3.74	1.99	-0.62	2.09
-0.0400	2.79	-2.36	3.65	1.84	-0.54	1.92
-0.0375	2.69	-2.33	3.56	1.68	-0.46	1.74
-0.0350	2.60	-2.29	3.46	1.52	-0.39	1.57
-0.0325	2.50	-2.25	3.36	1.37	-0.32	1.40
-0.0300	2.41	-2.19	3.26	1.21	-0.26	1.24
-0.0275	2.31	-2.13	3.14	1.06	-0.21	1.08
-0.0250	2.21	-2.06	3.02	0.92	-0.17	0.93
-0.0225	2.12	-1.98	2.90	0.78	-0.14	0.79
-0.0200	2.02	-1.89	2.77	0.65	-0.11	0.66
-0.0175	1.93	-1.80	2.64	0.53	-0.09	0.54
-0.0150	1.84	-1.70	2.50	0.42	-0.07	0.43
-0.0125	1.75	-1.59	2.37	0.33	-0.06	0.33
-0.0100	1.66	-1.49	2.23	0.24	-0.05	0.24
-0.0075	1.58	-1.39	2.10	0.16	-0.04	0.17

TABLE IV cont.

Velocity Data: Horse A

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.0050	1.50	-1.29	1.98	0.10	-0.04	0.10
-0.0025	1.42	-1.20	1.86	0.04	-0.04	0.06
0.0000	1.35	-1.11	1.74	-0.01	-0.04	0.04
0.0025	1.28	-1.03	1.64	-0.05	-0.03	0.06
0.0050	1.21	-0.96	1.55	-0.08	-0.03	0.08
0.0075	1.16	-0.89	1.46	-0.10	-0.03	0.11
0.0100	1.10	-0.83	1.38	-0.12	-0.02	0.13
0.0125	1.06	-0.78	1.32	-0.14	-0.02	0.14
0.0150	1.02	-0.74	1.26	-0.15	-0.01	0.15
0.0175	0.98	-0.70	1.20	-0.16	-0.01	0.16
0.0200	0.95	-0.66	1.16	-0.16	0.00	0.16
0.0225	0.92	-0.63	1.12	-0.17	0.01	0.17
0.0250	0.90	-0.60	1.08	-0.17	0.02	0.17
0.0275	0.88	-0.57	1.05	-0.17	0.03	0.17
0.0300	0.85	-0.55	1.01	-0.16	0.04	0.17
0.0325	0.83	-0.52	0.98	-0.16	0.06	0.17
0.0350	0.80	-0.49	0.94	-0.15	0.07	0.17
0.0375	0.76	-0.47	0.89	-0.14	0.09	0.17
0.0400	0.73	-0.44	0.85	-0.13	0.12	0.17
0.0425	0.69	-0.41	0.80	-0.11	0.14	0.18
0.0450	0.64	-0.38	0.74	-0.09	0.17	0.20
0.0475	0.59	-0.34	0.68	-0.06	0.21	0.22
0.0500	0.53	-0.31	0.62	-0.04	0.24	0.25
0.0525	0.47	-0.27	0.55	-0.01	0.28	0.28
0.0550	0.41	-0.23	0.47	0.02	0.32	0.32
0.0575	0.35	-0.19	0.40	0.05	0.37	0.37
0.0600	0.29	-0.14	0.32	0.08	0.41	0.42
0.0625	0.22	-0.10	0.25	0.12	0.46	0.48
0.0650	0.17	-0.05	0.18	0.15	0.51	0.54
0.0675	0.11	-0.01	0.11	0.19	0.57	0.60
0.0700	0.07	0.03	0.07	0.23	0.62	0.66
0.0725	0.02	0.08	0.08	0.27	0.68	0.73
0.0750	-0.01	0.11	0.12	0.32	0.74	0.80
0.0775	-0.04	0.15	0.16	0.36	0.80	0.87
0.0800	-0.07	0.19	0.20	0.40	0.85	0.94
0.0825	-0.09	0.22	0.24	0.44	0.91	1.01
0.0850	-0.10	0.26	0.28	0.49	0.97	1.08
0.0875	-0.11	0.29	0.32	0.53	1.02	1.15
0.0900	-0.12	0.33	0.35	0.57	1.06	1.20
0.0925	-0.13	0.37	0.39	0.60	1.10	1.26

TABLE IV cont.

Velocity Data: Horse A

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.0950	-0.13	0.41	0.43	0.63	1.13	1.30
0.0975	-0.12	0.46	0.47	0.66	1.16	1.33
0.1000	-0.12	0.50	0.52	0.67	1.17	1.35
0.1025	-0.11	0.55	0.56	0.68	1.18	1.36
0.1050	-0.10	0.59	0.60			
0.1075	-0.09	0.64	0.65			
0.1100	-0.08	0.69	0.69			
0.1125	-0.06	0.73	0.74			
0.1150	-0.05	0.78	0.78			
0.1175	-0.03	0.83	0.83			
0.1200	-0.01	0.87	0.87			
0.1225	0.00	0.92	0.92			
0.1250	0.02	0.96	0.97			
0.1275	0.03	1.01	1.01			
0.1300	0.05	1.06	1.06			
0.1325	0.06	1.1	1.1			
0.1350	0.07	1.15	1.15			
0.1375	0.07	1.19	1.19			
0.1400	0.07	1.23	1.23			
0.1425	0.08	1.27	1.27			
0.1450	0.07	1.3	1.31			
0.1475	0.07	1.34	1.34			
0.1500	0.06	1.37	1.37			
0.1525	0.05	1.4	1.4			
0.1550	0.05	1.43	1.43			
0.1575	0.04	1.46	1.46			
0.1600	0.03	1.48	1.48			
0.1625	0.02	1.5	1.5			
0.1650	0.02	1.51	1.51			
0.1675	0.01	1.52	1.52			
0.1700	0.01	1.53	1.53			

TABLE V

Velocity Data: Horse B

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.0850	3.64	-1.95	4.13	2.83	-2.24	3.61
-0.0825	3.55	-1.96	4.06	2.76	-2.20	3.53
-0.0800	3.46	-1.97	3.98	2.69	-2.15	3.45
-0.0775	3.36	-1.96	3.89	2.61	-2.09	3.35
-0.0750	3.26	-1.95	3.80	2.53	-2.03	3.24
-0.0725	3.15	-1.94	3.70	2.44	-1.95	3.13
-0.0700	3.04	-1.91	3.59	2.35	-1.87	3.00
-0.0675	2.93	-1.88	3.47	2.25	-1.78	2.87
-0.0650	2.80	-1.83	3.35	2.15	-1.68	2.73
-0.0625	2.68	-1.78	3.22	2.04	-1.58	2.58
-0.0600	2.55	-1.71	3.07	1.93	-1.47	2.43
-0.0575	2.42	-1.64	2.92	1.82	-1.36	2.27
-0.0550	2.28	-1.56	2.77	1.70	-1.24	2.10
-0.0525	2.15	-1.47	2.60	1.58	-1.13	1.94
-0.0500	2.00	-1.37	2.43	1.45	-1.01	1.77
-0.0475	1.86	-1.27	2.25	1.32	-0.90	1.60
-0.0450	1.71	-1.17	2.07	1.20	-0.80	1.44
-0.0425	1.57	-1.06	1.89	1.07	-0.70	1.28
-0.0400	1.42	-0.96	1.71	0.95	-0.61	1.13
-0.0375	1.27	-0.86	1.54	0.83	-0.52	0.98
-0.0350	1.13	-0.77	1.36	0.73	-0.44	0.85
-0.0325	0.99	-0.68	1.20	0.63	-0.36	0.72
-0.0300	0.85	-0.59	1.04	0.54	-0.29	0.62
-0.0275	0.73	-0.51	0.89	0.46	-0.23	0.52
-0.0250	0.61	-0.43	0.75	0.39	-0.18	0.43
-0.0225	0.50	-0.36	0.62	0.33	-0.14	0.36
-0.0200	0.41	-0.30	0.50	0.27	-0.10	0.29
-0.0175	0.32	-0.24	0.40	0.22	-0.08	0.24
-0.0150	0.24	-0.19	0.31	0.18	-0.05	0.19
-0.0125	0.18	-0.14	0.23	0.14	-0.04	0.15
-0.0100	0.12	-0.11	0.17	0.11	-0.02	0.11
-0.0075	0.08	-0.08	0.11	0.08	-0.02	0.08
-0.0050	0.04	-0.05	0.07	0.05	-0.01	0.05
-0.0025	0.02	-0.03	0.04	0.03	-0.01	0.03
0.0000	-0.01	-0.02	0.02	0.01	-0.01	0.01
0.0025	-0.02	-0.01	0.03	-0.01	-0.01	0.02
0.0050	-0.04	0.00	0.04	-0.03	-0.01	0.03
0.0075	-0.05	0.01	0.05	-0.04	-0.01	0.05
0.0100	-0.05	0.01	0.06	-0.06	-0.02	0.06

TABLE V cont.

Velocity Data: Horse B

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.0125	-0.06	0.02	0.06	-0.07	-0.01	0.07
0.0150	-0.06	0.02	0.06	-0.08	-0.01	0.08
0.0175	-0.06	0.02	0.07	-0.09	-0.01	0.09
0.0200	-0.06	0.02	0.07	-0.10	-0.01	0.10
0.0225	-0.06	0.03	0.06	-0.10	0.00	0.10
0.0275	-0.05	0.03	0.06	-0.10	0.00	0.10
0.0300	-0.05	0.03	0.06	-0.10	0.00	0.10
0.0325	-0.05	0.03	0.05	-0.10	0.01	0.10
0.0350	-0.04	0.03	0.05	-0.10	0.02	0.10
0.0375	-0.04	0.03	0.05	-0.09	0.02	0.10
0.0400	-0.04	0.03	0.05	-0.09	0.03	0.09
0.0425	-0.04	0.04	0.05	-0.08	0.04	0.09
0.0450	-0.04	0.04	0.06	-0.08	0.05	0.09
0.0475	-0.04	0.04	0.06	-0.07	0.06	0.09
0.0500	-0.04	0.05	0.06	-0.06	0.07	0.09
0.0525	-0.04	0.05	0.07	-0.05	0.08	0.10
0.0550	-0.04	0.06	0.07	-0.05	0.09	0.10
0.0575	-0.04	0.06	0.07	-0.04	0.11	0.12
0.0600	-0.04	0.06	0.07	-0.03	0.13	0.13
0.0625	-0.04	0.06	0.07	-0.03	0.14	0.15
0.0650	-0.04	0.06	0.07	-0.02	0.16	0.16
0.0675	-0.03	0.06	0.07	-0.01	0.19	0.19
0.0700	-0.03	0.06	0.07	0.00	0.21	0.21
0.0725	-0.03	0.06	0.06	0.01	0.25	0.25
0.0750	-0.02	0.05	0.06	0.03	0.28	0.28
0.0775	-0.01	0.05	0.05	0.05	0.32	0.32
0.0800	0.00	0.06	0.06	0.07	0.36	0.37
0.0825	0.01	0.06	0.06	0.09	0.41	0.42
0.0850	0.02	0.07	0.07	0.11	0.47	0.48
0.0875	0.03	0.09	0.09	0.13	0.52	0.54
0.0900	0.05	0.11	0.12	0.16	0.59	0.61
0.0925	0.06	0.13	0.15	0.18	0.65	0.68
0.0950	0.08	0.16	0.18	0.20	0.72	0.75
0.0975	0.10	0.20	0.22	0.23	0.79	0.83
0.1000	0.11	0.24	0.27	0.25	0.87	0.90
0.1025	0.13	0.29	0.32	0.28	0.94	0.98
0.1050	0.15	0.34	0.37	0.30	1.01	1.06
0.1075	0.18	0.40	0.44	0.33	1.08	1.13
0.1100	0.20	0.46	0.50	0.35	1.14	1.20
0.1125	0.23	0.53	0.57	0.37	1.20	1.26

TABLE V cont.

Velocity Data: Horse B

Units: meters/sec.

	Vault #1			Vault #2		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.1150	0.25	0.60	0.65	0.39	1.25	1.31
0.1175	0.29	0.67	0.73	0.41	1.29	1.35
0.1200	0.32	0.75	0.82	0.42	1.31	1.38
0.1225	0.35	0.84	0.91	0.43	1.33	1.40
0.1250	0.39	0.93	1.01	0.43	1.34	1.41
0.1275	0.43	1.02	1.10			
0.1300	0.46	1.11	1.20			
0.1325	0.50	1.20	1.30			
0.1350	0.53	1.29	1.40			
0.1375	0.56	1.38	1.49			
0.1400	0.59	1.46	1.58			
0.1425	0.61	1.54	1.65			
0.1450	0.62	1.60	1.72			
0.1475	0.63	1.65	1.77			
0.1500	0.64	1.68	1.80			
0.1525	0.65	1.70	1.82			

TABLE VI

Velocity Data: Horse B

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
-0.0850	4.02	-2.14	4.56	3.71	-2.25	4.34
-0.0825	4.00	-2.15	4.54	3.66	-2.26	4.30
-0.0800	3.98	-2.15	4.52	3.59	-2.26	4.24
-0.0775	3.93	-2.16	4.49	3.52	-2.26	4.18
-0.0750	3.87	-2.17	4.44	3.44	-2.25	4.11
-0.0725	3.80	-2.18	4.38	3.36	-2.24	4.04
-0.0700	3.70	-2.19	4.30	3.27	-2.22	3.95
-0.0675	3.60	-2.19	4.21	3.18	-2.19	3.86
-0.0650	3.48	-2.20	4.11	3.08	-2.15	3.76
-0.0625	3.35	-2.19	4.00	2.97	-2.11	3.64
-0.0600	3.20	-2.18	3.87	2.86	-2.05	3.52
-0.0575	3.04	-2.16	3.73	2.75	-1.98	3.39
-0.0550	2.88	-2.12	3.57	2.63	-1.90	3.25
-0.0525	2.71	-2.07	3.41	2.51	-1.81	3.09
-0.0500	2.53	-2.00	3.22	2.38	-1.71	2.93
-0.0475	2.34	-1.92	3.03	2.25	-1.60	2.76
-0.0450	2.16	-1.83	2.83	2.11	-1.48	2.58
-0.0425	1.97	-1.72	2.62	1.97	-1.35	2.39
-0.0400	1.79	-1.60	2.40	1.83	-1.22	2.20
-0.0375	1.61	-1.47	2.18	1.68	-1.10	2.01
-0.0350	1.43	-1.34	1.96	1.54	-0.97	1.82
-0.0325	1.26	-1.20	1.74	1.39	-0.85	1.63
-0.0300	1.10	-1.07	1.53	1.24	-0.74	1.44
-0.0275	0.95	-0.94	1.33	1.10	-0.63	1.27
-0.0250	0.81	-0.81	1.14	0.95	-0.54	1.09
-0.0225	0.68	-0.68	0.96	0.82	-0.45	0.93
-0.0200	0.56	-0.57	0.80	0.69	-0.36	0.78
-0.0175	0.45	-0.47	0.65	0.57	-0.29	0.64
-0.0150	0.35	-0.38	0.52	0.45	-0.23	0.51
-0.0125	0.27	-0.30	0.40	0.35	-0.17	0.39
-0.0100	0.19	-0.23	0.30	0.26	-0.13	0.29
-0.0075	0.13	-0.17	0.21	0.19	-0.09	0.21
-0.0050	0.07	-0.13	0.14	0.12	-0.06	0.13
-0.0025	0.02	-0.09	0.09	0.06	-0.04	0.07
0.0000	-0.02	-0.06	0.06	0.01	-0.02	0.02
0.0025	-0.05	-0.03	0.06	-0.03	0.00	0.03
0.0050	-0.08	-0.01	0.08	-0.06	0.01	0.06
0.0075	-0.10	0.01	0.10	-0.09	0.01	0.09
0.0100	-0.12	0.02	0.12	-0.11	0.02	0.11

TABLE VI cont.

Velocity Data: Horse B

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.0125	-0.14	0.03	0.14	-0.12	0.02	0.12
0.0150	-0.15	0.04	0.15	-0.13	0.02	0.13
0.0175	-0.16	0.05	0.16	-0.14	0.01	0.14
0.0200	-0.16	0.05	0.17	-0.15	0.01	0.15
0.0225	-0.16	0.06	0.17	-0.15	0.01	0.15
0.0275	-0.16	0.07	0.18	-0.15	0.00	0.15
0.0300	-0.16	0.07	0.17	-0.15	0.00	0.15
0.0325	-0.15	0.08	0.17	-0.15	0.00	0.15
0.0350	-0.14	0.09	0.16	-0.14	0.00	0.15
0.0375	-0.12	0.10	0.16	-0.14	0.01	0.14
0.0400	-0.11	0.11	0.16	-0.14	0.01	0.14
0.0425	-0.10	0.12	0.15	-0.13	0.02	0.13
0.0450	-0.09	0.13	0.15	-0.12	0.03	0.13
0.0475	-0.07	0.14	0.16	-0.12	0.04	0.12
0.0500	-0.06	0.15	0.16	-0.11	0.05	0.12
0.0525	-0.05	0.16	0.17	-0.10	0.06	0.12
0.0550	-0.03	0.17	0.18	-0.09	0.07	0.12
0.0575	-0.02	0.19	0.19	-0.09	0.07	0.11
0.0600	-0.01	0.20	0.20	-0.08	0.08	0.12
0.0625	0.01	0.22	0.22	-0.08	0.09	0.12
0.0650	0.03	0.24	0.24	-0.07	0.10	0.12
0.0675	0.04	0.26	0.26	-0.06	0.10	0.12
0.0700	0.06	0.28	0.29	-0.06	0.11	0.12
0.0725	0.08	0.31	0.32	-0.05	0.12	0.13
0.0750	0.10	0.35	0.36	-0.05	0.13	0.14
0.0775	0.12	0.39	0.40	-0.04	0.14	0.14
0.0800	0.13	0.43	0.45	-0.04	0.15	0.16
0.0825	0.15	0.48	0.50	-0.03	0.17	0.17
0.0850	0.16	0.53	0.55	-0.02	0.18	0.18
0.0875	0.17	0.58	0.61	-0.01	0.20	0.20
0.0900	0.18	0.64	0.67	0.00	0.22	0.22
0.0925	0.19	0.70	0.73	0.01	0.25	0.25
0.0950	0.19	0.77	0.79	0.02	0.28	0.28
0.0975	0.19	0.83	0.86	0.03	0.31	0.31
0.1000	0.20	0.90	0.92	0.05	0.35	0.35
0.1025	0.20	0.97	0.99	0.06	0.39	0.40
0.1050	0.20	1.03	1.05	0.07	0.44	0.45
0.1075	0.21	1.10	1.11	0.09	0.49	0.50
0.1100	0.21	1.15	1.17	0.11	0.55	0.56
0.1125	0.21	1.21	1.23	0.13	0.61	0.62

TABLE VI cont.

Velocity Data: Horse B

Units: meters/sec.

	Vault #3			Vault #4		
time	x comp.	y comp.	result.	x comp.	y comp.	result.
0.1150	0.22	1.26	1.28	0.14	0.67	0.69
0.1175	0.22	1.30	1.32	0.16	0.74	0.75
0.1200	0.23	1.34	1.36	0.18	0.80	0.82
0.1225	0.24	1.37	1.39	0.20	0.86	0.88
0.1250	0.24	1.39	1.41	0.21	0.91	0.94
0.1275	0.24	1.40	1.42	0.23	0.96	0.99
0.1300	0.24	1.41	1.43	0.24	1.01	1.03
0.1325				0.24	1.04	1.07
0.1350				0.25	1.07	1.10
0.1375				0.25	1.09	1.12
0.1400				0.25	1.11	1.13
0.1425				0.25	1.11	1.14
0.1450						
0.1475						
0.1500						
0.1525						

Figure 4 shows the path of the target over time for each of the vaults by both gymnasts on Horse A. Figure 5 shows the path of the target over time for each vault by both gymnasts on Horse B. In Figures 4-7, curves 1 and 3 represent the vaults by the first gymnast and curves 2 and 4 represent the vaults by the second gymnast.

As shown by reference to Figure 4, substantial slipping was encountered during each of the vaults performed on Horse A, i.e., with a conventional cover. In distinction, as is readily determined from Figure 5, very little slipping was encountered during the vaults on Horse B. Using the slip control sheeting of the invention, the gymnasts were able to perform four, very uniform vaults.

Figure 6 is a graphical illustration of the resultant velocities of the gymnasts in the vaults shown in Figure 4 and Figure 7 is a corresponding graphical illustration of the resultant velocities of the gymnasts in the vaults shown in Figure 5. "Resultant velocity" is the magnitude of the vector sum of the vertical and horizontal velocities as calculated from the tables.

Claims

1. A slip control sheeting comprising a backing (12) having a first and a second major surface (14, 16) and an array of protrusions (22) on said first major surface (14), characterized in that said protrusions (22) have a height of between 75 and 750 μm, said protrusions (22) comprise at least one of pyramids with polygonal bases or pyramidal frustums with polygonal bases, said array is defined in part by a pattern of intersecting sets of parallel grooves (a, b, c) formed in said first major surface (14), which grooves define major axes of said sheeting, and at least one of the following:

   a) said sheeting comprises at least one of a layer of adhesive (18) on said second major surface (16), a reinforcing web, or a mechanical fastening component for fastening said backing to a substrate; and
   b) said sheeting retroreflects less than 10 percent of a beam of electromagnetic radiation which is incident at any angle to said second major surface, the electromagnetic radiation having any wavelength from 0.39 μm to 1,000 μm.

2. The sheeting of claim 1 further characterized in that said sheeting includes said adhesive layer (18), and said adhesive layer (18) is selected from the group consisting of heat-activated adhesives, pressure-sensitive adhesives, and mixtures thereof.

3. The sheeting of claim 1 further characterized in that said sheeting includes said reinforcing web, and said reinforcing web is at least partially embedded in said backing (12).

4. The sheeting of claim 1 further characterized in that said sheeting includes said mechanical fastening component, and said mechanical fastening component comprises a structured surface which includes a plurality of tapered elements, each tapered element comprising a side which is inclined relative to the plane of the structured surface at an angle sufficient to form a taper such that each tapered element is adapted to mate with at least one corresponding element of a complementarily structured surface of a substrate.

5. The sheeting of claim 1 further characterized in that said polygonal bases of said protrusions are selected from the group consisting of triangular bases, quadrilateral bases, pentagonal bases, hexagonal bases, heptagonal bases, octagonal bases, nonagonal bases and decagonal bases.

6. The sheeting of claim 1 further characterized in that said protrusions are pyramids with triangular bases.

7. The sheeting of claim 1 further characterized in that said polygonal bases of said protrusions are immediately adjacent one another.

8. The sheeting of claim 1 further characterized in that said sheeting is sufficiently flexible to be wound about itself on a 2.54 centimeter diameter mandrel.

9. A tool, mallet, racquet, baseball bat, golf club, or sport stick, to the handle of which has been applied a sheeting according to claim 1 or an eye glass to the support surface of which has been applied a sheeting according to claim 1 or a diving board to the surface of which has been applied a sheeting according to claim 1, or a glove to the gripping surface of which has been applied a sheeting according to claim 1.

10. Gymnastic apparatus to at least a portion of the surface of which has been applied a sheeting according to claim 1.

Patentansprüche

1. Rutschfester Belag, umfassend eine Unterlage (12) mit einer ersten und zweiten größeren Oberfläche (14,16) und einer Anordnung von Erhebungen (22) auf der ersten größeren Oberfläche (14), dadurch gekennzeichnet, daß die Erhebungen (22) eine Höhe zwischen 75 und 750 Mikrometer aufweisen, daß die Erhebungen mindestens eine Pyramide mit polygonaler Grundfläche oder einen Pyramidenstumpf mit polygonaler Grundfläche umfassen, wobei die Anordnung zum Teil festgelegt ist durch ein Muster einer Reihe sich schneidender paralleler, in der ersten größeren Oberfläche (14) gebildeter Rillen (a,b,c), welche Rillen Hauptachsen des Belags festlegen, sowie mit mindestens einem der folgenden:

   (a) der Belag umfaßt mindestens eine Klebstoffschicht (18) auf der zweiten größeren Oberfläche (16), eine verstärkende Bahn oder ein mechanisches Befestigungsteil zum Befestigen der Unterlage an einem Substrat; sowie
   (b) der Belag retroreflektiert weniger als 10 Prozent eines Strahls elektromagnetischer Strahlung, der zur zweiten größeren Oberfläche in einem beliebigen Winkel einfällt, wobei die elektromagnetische Strahlung eine beliebige Wellenlänge zwischen 0,39 und 1.000 Mikrometer hat.

2. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß der Belag die Klebstoffschicht (18) umfaßt und die Klebstoffschicht (18) ausgewählt wird aus der Gruppe, bestehend aus wärmeaktivierbaren Klebstoffen, Haftklebstoffen und Mischungen davon.

3. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß der Belag eine verstärkende Bahn umfaßt und die verstärkende Bahn mindestens teilweise in der Unterlage (12) eingebettet ist.

4. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß der Belag ein mechanisches Befestigungsteil umfaßt und das mechanische Befestigungsteil eine strukturierte Oberfläche mit einer vielzahl sich verjüngender Elemente aufweist, wobei jedes sich verjüngende Element eine Seite aufweist, die relativ zur Ebene der strukturierten Ober-

fläche in einem Winkel geneigt ist, der ausreichend ist, um derart einen Konus zu bilden, daß jedes sich verjüngende Element in mindestens ein entsprechendes Element einer komplementär strukturierte Oberfläche eines Substrats eingreifen kann.

5. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß die polygonalen Grundflächen der Erhebungen ausgewählt werden aus der Gruppe, bestehend aus dreieckigen Grundflächen, vierseitigen Grundflächen, pentagonalen Grundflächen, hexagonalen Grundflächen, heptagonalen Grundflächen, oktagonalen Grundflächen, nonagonalen Grundflächen und dekagonalen Grundflächen.

6. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß die Erhebungen Pyramiden mit dreieckigen Grundflächen sind.

7. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß die polygonalen Grundflächen der Erhebungen unmittelbar aneinander angrenzen.

8. Belag nach Anspruch 1, ferner dadurch gekennzeichnet, daß der Belag ausreichend flexibel ist, um auf einen Wikkeldorn mit einem Durchmesser von 2,54 cm aufgewickelt zu werden.

9. Werkzeug, Schlegel, Racquet, Baseballschläger, Golfschläger oder Sportschläger, auf deren Handgriffe ein Belag nach Anspruch 1 aufgebracht wurde, oder Brille, auf deren haltende Oberfläche ein Belag nach Anspruch 1 aufgebracht wurde, oder Sprungbrett, auf dessen Oberfläche ein Belag nach Anspruch 1 aufgebracht wurde, oder Handschuh, auf dessen Griff-Fläche ein Belag nach Anspruch 1 aufgebracht wurde.

10. Turngerät mit mindestens auf einem Teil seiner Oberfläche aufgebrachten Belag nach Anspruch 1.

Revendications

1. Revêtement antidérapant comprenant un support (12), qui présente une première et une deuxième surfaces principales (14, 16), et un réseau de protubérances (22) sur la dite première surface principale (14), caractérisé en ce que les dites protubérances (22) ont une hauteur comprise entre 75 et 750 μm, les dites protubérances (22) comprennent au moins un type de pyramides à bases polygonales ou de troncs de pyramide à bases polygonales, et le dit réseau est défini en partie par une configuration d'ensembles en intersection de rainures parallèles (a, b, c) formées dans la dite première surface principale (14), ces rainures définissant les axes principaux du dit revêtement, et au moins un des aspects suivants :

   (a) le dit revêtement comprend au moins un élément choisi parmi une couche d'adhésif (18) sur la dite deuxième surface principale (16), une toile de renforcement ou un composant de fixation mécanique, pour fixer le dit support à un substrat ; et
   (b) le dit revêtement rétroréfléchit moins de 10 % d'un faisceau de rayonnement électromagnétique qui est incident suivant un angle quelconque sur la dite deuxième surface principale, le rayonnement électromagnétigue ayant une longueur d'onde comprise entre 0,39 μm et 1000 μm.

2. Revêtement suivant la revendication 1, caractérisé en outre en ce que le dit revêtement comprend la dite couche adhésive (18), et la dite couche adhésive (18) est choisie dans le groupe constitué d'adhésifs thermo-activés, d'adhésifs sensibles à la pression et de leurs mélanges.

3. Revêtement suivant la revendication 1, caractérisé en outre en ce que le revêtement comprend la toile de renforcement, et la dite toile de renforcement est au moins partiellement noyée dans le dit support (12).

4. Revêtement suivant la revendication 1, caractérisé en outre en ce que le dit revêtement comprend le dit composant de fixation mécanique, et le dit composant de fixation mécanique présente une surface structurée qui comporte une pluralité d'éléments coniques, chaque élément conique présentant une face qui est inclinée par rapport au plan de la surface structurée suivant un angle suffisant pour former un cône,de sorte que chaque élément conique peut s'accoupler avec au moins un élément correspondant d'une surface structurée de façon complémentaire d'un substrat.

5. Revêtement suivant la revendication 1, caractérisé en outre en ce que les dites bases polygonales des dites protubérances sont choisies dans le groupe comprenant des bases triangtulaires, des bases en quadrilatère, des

bases pentagonales, des bases hexagonales, des bases heptagonales, des bases octogonales, des bases nonagonales et des bases décagonales.

6. Revêtement suivant la revendication 1, caractérisé en outre en ce que les dites protubérances sont des pyramides à base triangulaire.

7. Revêtement suivant la revendication 1, caractérisé en outre en ce que les dites bases polygonales des dites protubérances sont immédiatement adjacentes les unes aux autres.

8. Revêtement suivant la revendication 1, caractérisé en outre en ce que le dit revêtement est suffisamment flexible pour qu'on puisse l'enrouler sur lui-même autour d'un mandrin de 2,54 cm de diamètre.

9. Outil, maillet, raquette, batte de baseball, club de golf ou canne de sport, au manche duquel a été appliqué un revêtement suivant la revendication 1, ou lunettes à la surface d'appui desquelles a été appliqué un revêtement suivant la revendication 1, ou planche de plongeoir à la surface de laquelle a été appliqué un revêtement suivant la revendication 1, ou gant à la surface de prise duquel a été appliqué un revêtement suivant la revendication 1.

10. Appareil de gymnastique à au moins une partie de la surface duquel a été appliqué un revêtement suivant la revendication 1.

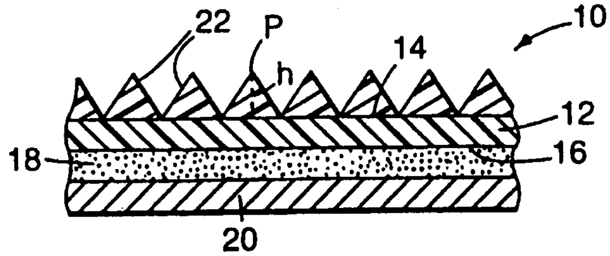


Fig. 1

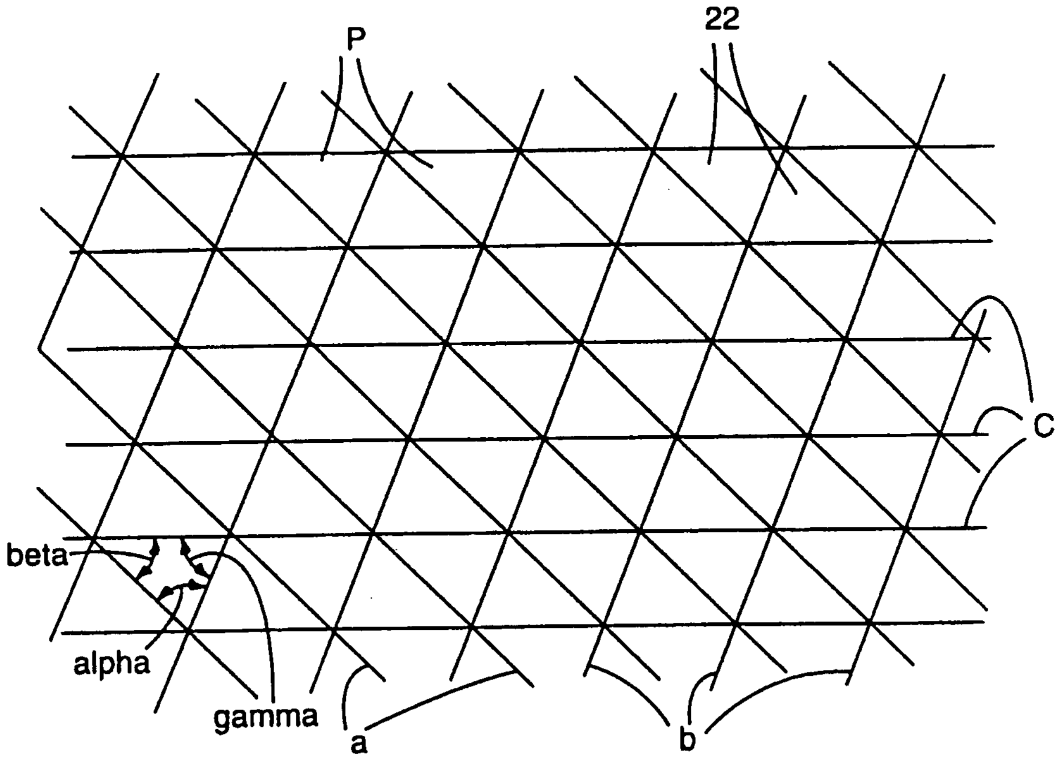


Fig. 2

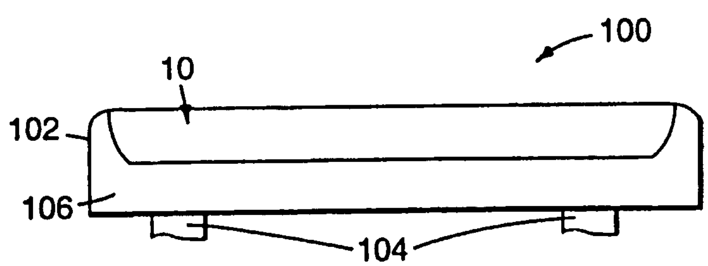
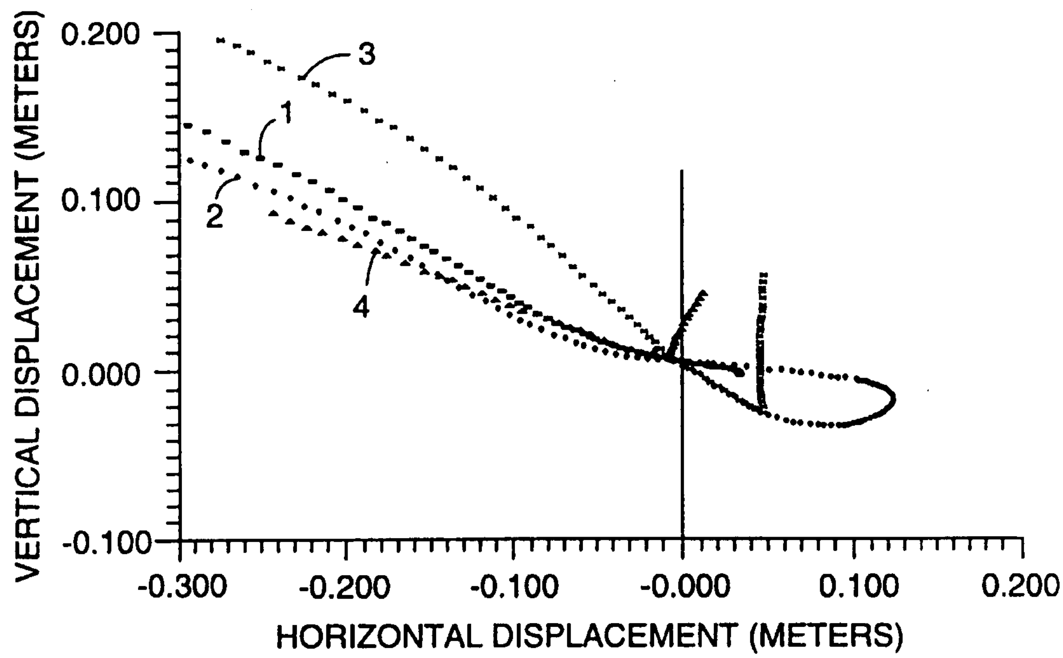


Fig. 3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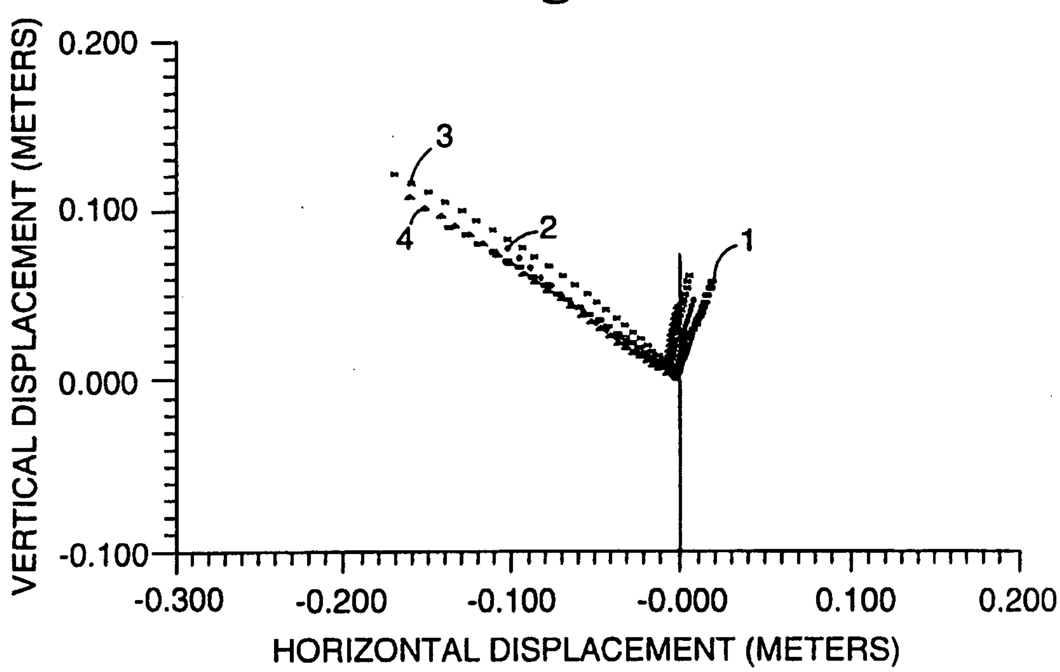
0.000
-0.100
-0.300
-0.200
-0.100
-0.000
0.100
0.200
HORIZONTAL DISPLACEMENT (METERS)
1
2
3
4

Fig. 4


VERTICAL DISPLACEMENT (METERS)
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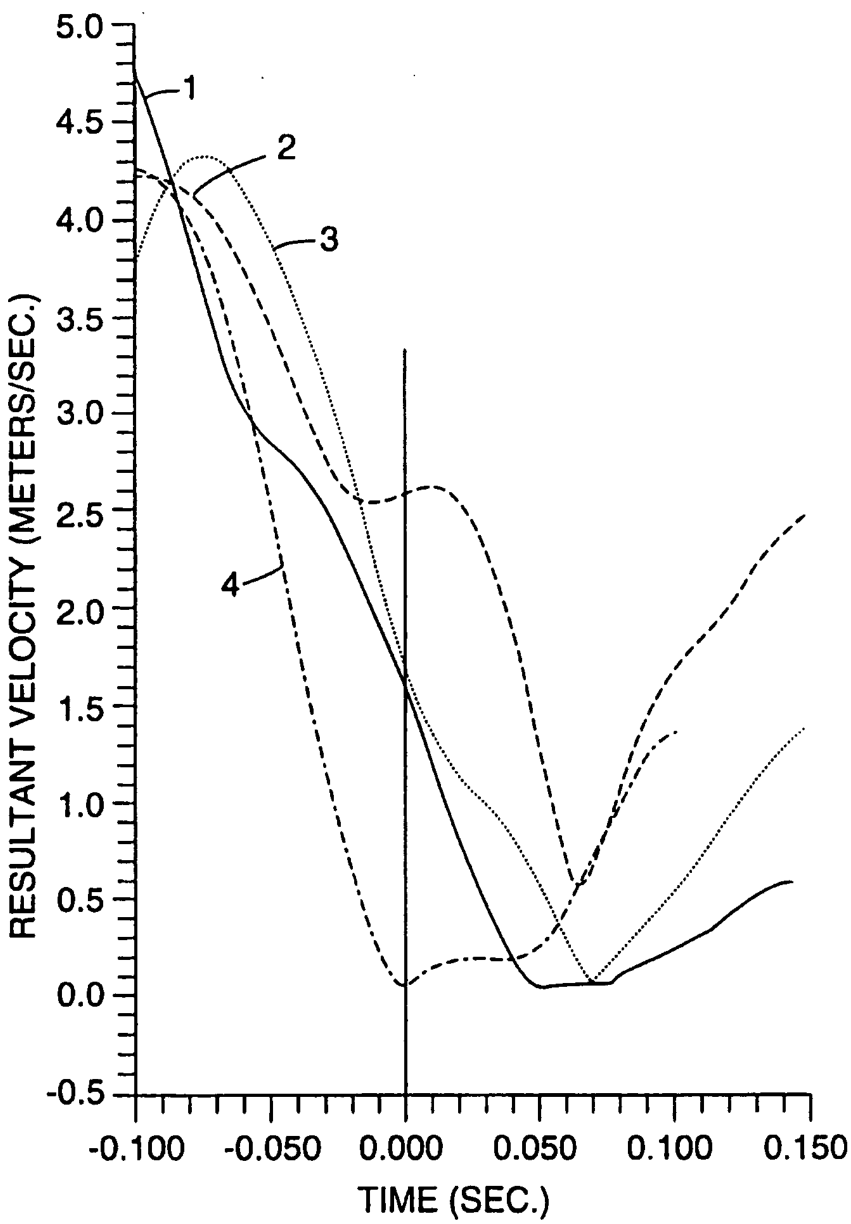
0.100
0.000
-0.100
-0.300
-0.200
-0.100
-0.000
0.100
0.200
HORIZONTAL DISPLACEMENT (METERS)
1
2
3
4

Fig. 5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4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
RESULTANT VELOCITY (METERS/SEC.)
1
2
3
4
-0.100
-0.050
0.000
0.050
0.100
0.150
TIME (SEC.)

Fig. 6

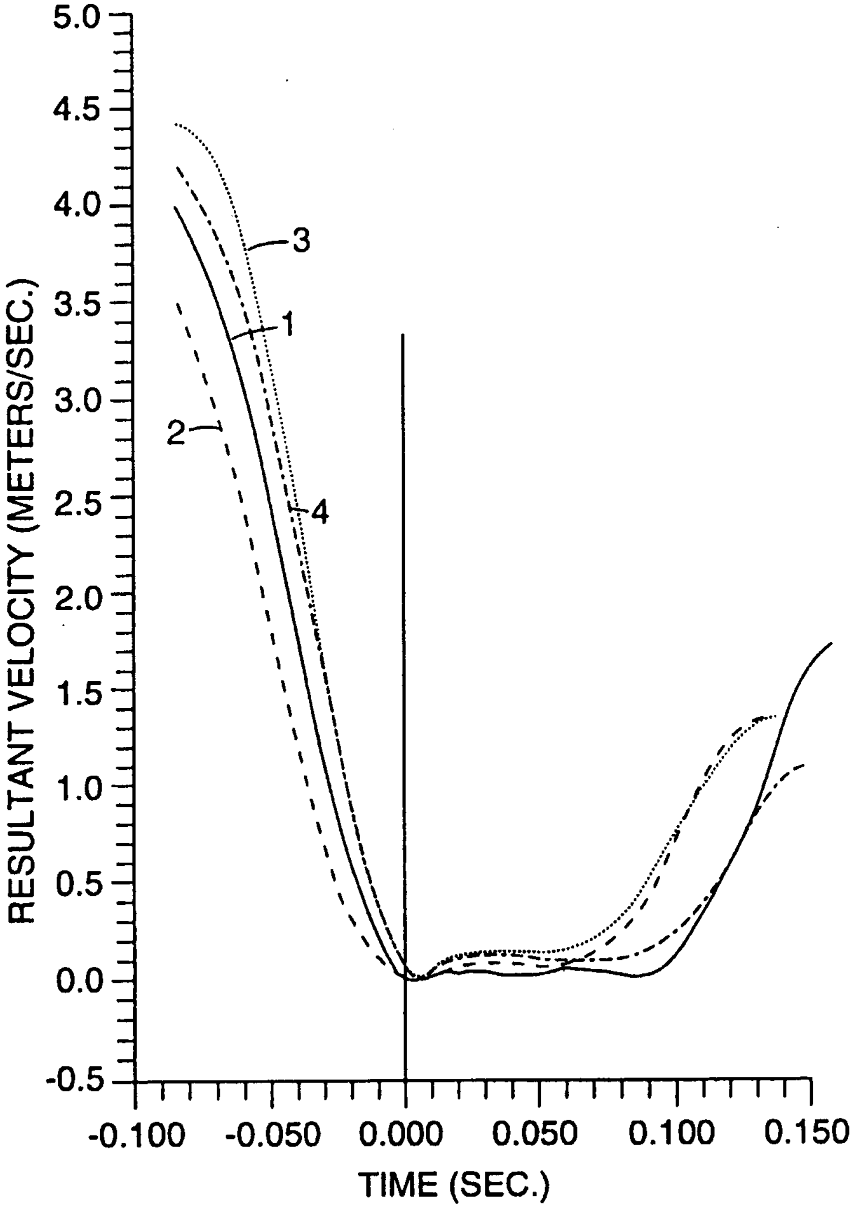
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
RESULTANT VELOCITY (METERS/SEC.)
3
1
2
4
-0.100
-0.050
0.000
0.050
0.100
0.150
TIME (SEC.)

Fig. 7